# Section 4: Aquatic Ecosystem

Since French explorer Étienne Brûlé first saw Lake Huron in 1612, the lake ecosystem has undergone many changes. Among the most significant change to the fish community have been the invasion of rainbow smelt (*Osmerus mordax*) in the 1920's, and alewife (*Alosa pseudoharengus*) and sea lamprey (*Petromyzon marinus*) in the 1930s. Sea lamprey predation and overfishing led to the collapse of lake trout (*Salvelinus namaycush*) by the 1950's (although two remnant stocks barely survived). With no predators to control alewife and smelt populations their numbers exploded and nuisance die-offs of alewife commonly littered beaches during the 1960s.

The turnaround came with sea lamprey control in the 1960s which allowed the survival of stocked Pacific salmon (*Oncorhynchus spp.*), lake trout and other predators. Restocking controlled both smelt and alewife populations, prevented nuisance alewife die-offs and resulted in exceptionally good fishing.

## 4.1 Lake Huron Aquatic Foodweb

The original Lake Huron ecosystem had lake trout as the main predator together with burbot (*Lota lota*) in the deeper waters, and walleye (*Sander vitreus*) the main nearshore area predator. The historic prey base was dominated by lake herring (or cisco) (*Coregonus artedii*) and a number of other species of deepwater ciscos (*Coregonus spp.*), with sculpins (*Cottus spp.* and *Myoxocephalus quadricornis*), lake (*Coregonus clupeaformis*) and round whitefish (*Prosopium cylindraceum*) contributing to a lesser extent.

The historic Lake Huron off-shore ecosystem had fewer predators and many more prey fish species. The current ecosystem has many more predators and both predators and prey are dominated by introduced species. Many of the original deepwater cisco species in Lake Huron are extirpated. (Refer to the section divider for illustration of aquatic ecosystem.)



Today chinook salmon (*Oncorhynchus tshawytscha*) are the dominant consumer in the lake, feeding mainly on non-native forage (alewife are their main prey with smelt being second) and lake trout are still a significant factor due to continued stocking. The abundance of both alewife and smelt can fluctuate significantly between years which can influence growth rates and survival of predators.

Six sites of natural reproduction of lake trout have been documented on Lake Huron and one has been deemed rehabilitated. Despite this level of success much work is needed to rehabilitate lake trout to even a small portion of their former abundance across the lake.

On Lake Huron the impact of industrialization and human population density has not been as great as on some of the other Great Lakes. The lake is, however, vulnerable from future impacts due to it's being within easy commuting distance of much higher population areas and is a popular destination for millions of cottagers, tourists and anglers. The mounting development pressures on Lake Huron from improved highways, and diminishing resources in other locations, will likely increase harvest and development pressure and strain the achievement of resource sustainability. Continued vigilance is needed to insure that future development on Lake Huron is done in a sound ecologically sustainable manner while efforts to seek solutions to existing problems continue to occur.

## 4.2 Fishery Management Goals

Fish Community Objectives (FCO) for Lake Huron were developed in 1995, and were in most cases yield targets by species based on historic commercial fishery landings from 1912-1940. An emerging realization is that historic harvest, and even current levels for some species, may not be sustainable in the long-term. Historic commercial fishery practices such as switching to different targeted species, fishing different fish stocks, changes in fishing effort and fishing power may all have masked the steady decline of fish populations over this historic time period.

In addition, the current ecosystem may not be as productive as in the past since non-native prey species are not as efficient in utilizing the primary and secondary production of the lake as were historic species,

such as the diversity of ciscos that once inhabited the lake. The introduction of non-native species such as zebra (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugensis*) and the spiny water flea (*Bythotrephes cederstroemi*) may also divert much of the primary and secondary production of the lake to different pathways, making it unavailable to top predators.

Non-native salmonids which feed almost exclusively on alewife and smelt, are likely less efficient at utilizing productivity than indigenous lake trout, in that lake trout has a much more varied diet and would historically have utilized some portion of the available benthic prey in addition to forage fish to support their population size.

Taken in context, historic yield can provide an idea of what a fully recovered fish community might sustain rather than a specific target. The Great Lakes Fishery Commission (GLFC) currently facilitates the publishing of State of the Lake Reports for each of the Great Lakes on a five year rotation. A critical review of the lake status relative to FCOs is currently being conducted and FCOs will be updated as required.

To better facilitate the cooperative management of fisheries resources a framework for inter-jurisdictional coordination of fisheries management based upon an ecosystem context was developed. This "ecosystem approach" to fisheries management recognizes that the resources of the Great Lakes must be managed as a whole, that healthy fish communities require functioning, diverse habitats and clean water. FCOs for Lake Huron were completed in 1995 and described what was considered a "desirable" fish community based upon accepted ecological concepts and guiding principles. In order to support these FCOs, Environmental Objectives (EOs) are being developed to describe the biological, chemical and physical needs of these desired fish communities. The rehabilitation of Saginaw Bay, which once accounted for a significant proportion of lake wide yield of fish species, and making stream habitats currently blocked by man-made barriers available to migrating fish, rank as key targets for future habitat work.



With multiple resource agency input, the development of draft EOs was initiated in 2002 and the current version is undergoing critical review. These draft EOs provide a summary of the major environmental impediments to achieving FCOs in Lake Huron. A summary of the draft Environmental Objectives is provided below:

### 4.2.1 Spawning and Nursery Habitats

**Maintain, protect and restore the integrity and connectivity of wetland spawning, nursery and feeding areas throughout the Lake Huron basin.** Coastal wetlands throughout Lake Huron provide critical spawning, nursery and feeding habitat for a variety of fish species. Northern pike (*Esox lucius*) and muskellunge (*Esox masquinongy*) spawn exclusively in wetland areas whereas other species such as yellow perch (*Perca flavescens*), walleye, and minnow species use these areas as nursery and feeding sites. Historical losses of Lake Huron wetlands through drainage, infilling and other physical alterations have been significant. Many remaining wetlands are degraded or no longer accessible due to shoreline armoring.

**Protect and restore connectivity and functionality of tributary spawning and nursery areas throughout the Lake Huron Basin.** The Lake Huron watershed is one of the largest in the Great Lakes with numerous rivers and streams draining into the basin. The principal spawning and nursery habitats for a variety of species including lake sturgeon (*Acipenser fluvescens*), walleye, pacific salmonids (*Oncorhynchus spp*.), and suckers (*Catostomus spp*.) are found in these tributaries. Unfortunately, rivers and streams are some of the most altered and disrupted habitats in the Lake Huron basin. Many of the watersheds draining into Lake Huron have barriers to upstream access and have flow regimes that have been altered as a result of watershed land-use changes or hydro-electric generation needs.

**Protect and restore reef spawning areas throughout the Lake Huron Basin.** Lake Huron is a deep oligotrophic lake with a fish community that was historically dominated by deep dwelling species such as lake trout, whitefish and ciscoes. Most of these species utilize offshore or nearshore reefs for spawning purposes. Nearshore and offshore reefs are one of the most common habitat features throughout the Lake Huron basin. For the most part these habitats have not been physically altered to the same extent as

other habitat types, however, the colonization of these habitats by invasive species such as zebra mussels and round goby (*Neogoblus melanostomus*) has accelerated in recent years and may in time degrade the quality of these habitats.

### 4.2.2 Shoreline Processes

**Protect and rehabilitate nearshore habitats and reestablish the beneficial structuring forces of natural water exchanges, circulation, and flow that they provide.** The alteration of nearshore areas due to human activities has been widespread throughout the Lake Huron basin but has been most pronounced in the populated areas in the southern part of the basin. Shoreline straightening, infilling, dredging, and other such activities alter nearshore currents, increase erosion and deposition of fine sediments and leads to the loss of habitat diversity. Since a majority of fish species inhabiting the basin use nearshore areas at some point in their life-cycle altering these areas results in the loss of fish production and change in fish community structure.

### 4.2.3 Food Web Structure and Invasive Species

**Protect and where possible enhance or restore fish community structure and function by promoting native species abundance and diversity and avoiding further invasive species introductions. In particular, protect and restore keystone predators to control exotic species and cultivate a food web favorable to reproduction of native species.** Fish communities throughout the Lake Huron basin have undergone substantive change over the last century. Historically, the offshore fish communities were characteristic of a large, deep oligotrophic lake with lake trout and burbot being the dominant predators and a variety of cisco species being the dominant prey species. In the nearshore waters, a relatively greater diversity of predators (walleye, northern pike, muskellunge, bass (*Micropterus spp.*)) were present as well as benthivores (sturgeon, suckers, channel catfish (*Ictalurus punctatus*)) and forage fish (herring, yellow perch, cyprinids). A variety of factors have been implicated in the loss or extinction of species in the basin and prominent among them is the proliferation of invasive species such as lamprey, alewife, rainbow smelt, and zebra mussels.



### 4.2.4 Water Quality

**Protect and restore water quality throughout the Lake Huron basin, especially in the Areas of Concern and reduce or remove contaminant burdens from the fish community in order to avoid reductions in fish production and native species biodiversity, and to maintain fishable, swimmable, aesthetically unaltered waters for the enjoyment of future generations.** Water quality throughout the Lake Huron basin has shown gradual improvement since the early 1970's. Some localized nutrient enrichment problems exist in Saginaw Bay and southeastern main basin and in northeastern Manitoulin Island. Acid rain and heavy metal contamination is still a localized issue in some parts of the North Channel and Georgian Bay. Consumption advisories due to contaminant levels are in place throughout the basin for a variety of fish species.

## 4.3 Invasive Species

Lake Huron has been dramatically and forever changed by the invasion of non-native species, which have decimated native fish populations and in some cases permanently impacted fish communities. Invasive species are defined as species that do not originate in the Lake Huron ecosystem and have been introduced either intentionally or accidentally. Invasive species threaten the diversity and abundance of native species and the ecological stability of infested waters.

The introduction of invasive species into Lake Huron has altered or disrupted existing relationships and ecological processes. This disruption can cause significant changes to the Lake Huron ecosystem such as alterations of food webs, nutrient dynamics, reproduction, sustainability, and biodiversity. Invasive species have few natural enemies such as pathogens, parasites and predators. Without co-evolved parasites and predators, they out-compete and even displace native populations. Not only do invasive species

compete with native species for food and habitat, they may also increase cycling of persistent bioaccumulative chemicals in the food chain. For example, research has shown that zebra mussels and round gobies are contributing to the cycling and bioaccumulation of PCBs (Jude 1996).

The recent invasion of zebra and quagga mussels, round gobies, the spiny water flea, white perch (*Morone Americana*) and ruffe (*Gymnocephalus cemuus*) into Lake Huron heightens the uncertainty for expectations from the ecosystem. Recently *Diporeia hoyi* (scud), a native invertebrate has declined significantly in abundance, especially in southern Lake Huron. There is a suspicion that the Diporeia decline may be related to the invasion of zebra mussels. Diporeia is a key diet item of lake whitefish and other desirable sport and commercial fish species.

The following is a description of a number of invasive species having a significant impact on the Lake Huron aquatic ecosystem.

### 4.3.1 Sea Lamprey

The sea lamprey has been a serious problem in the Great Lakes for more than 50 years. An adult lamprey can kill up to 40 pounds of fish in just 12 to 20 months. The St. Marys River, which flows between Lakes Superior and Huron has become the most important spawning area for lampreys in the Great Lakes.

Successful rehabilitation of Lake Huron lake trout populations has been hindered because of the high number of sea lamprey. Without question the sea lamprey problem in northern Lake Huron, associated with increased lamprey production from the St. Marys River, is the most severe impediment to a healthy fish community in the lake. By the1990's the St. Marys River was producing more sea lampreys than all other Great Lakes spawning tributaries combined.



Cost-effective sea lamprey control on the St. Marys, once thought to be impossible, may now be within reach because of a special program developed by biologists and research scientists working under the direction of the Great Lakes Fishery Commission. During 1998 – 1999, more than 840 hectares of the St. Marys River were treated with Bayluscide 3.2 percent Granular Sea Lamprey Larvicide. Additional treatments of sea lamprey "hot-spots" in the river have been conducted in more recent years. These treatments reduced the number of larval sea lampreys in the river by nearly 45 percent. Enhanced trapping and release of sterile male lampreys in the river reduced the reproduction potential by an estimated 92 percent. Although the Great Lakes Fishery Commission's fish community objective for sea lamprey (75 percent reduction) was not met for year 2000, the objective for 2010 (90 percent reduction) is attainable. However, funding for sea lamprey control remains at approximately 65 percent of that needed to fully fund the program.

### 4.3.2 Round Goby

The round goby are a small fish that feed chiefly on bivalves, amphipod, crustaceans, and small fish and fish eggs (Jude 1996). Consumption studies of fish suggest round gobies might have a detrimental impact on native species through competition for food and predation on eggs and young fish. To help control the expansion of the goby into other waterways, river barrier systems are being implemented along with aggressive public education programs. Unfortunately, no effective measures have been found to decrease established populations of goby.

### 4.3.3 Ruffe

The ruffe was first identified in Lake Huron in 1995 in Thunder Bay near Alpena, Michigan. The Ruffe adapts well to various environments, matures quickly, and spawns over an extended period of time. With a high level of adaptability, ruffe populations are on the rise, yet they have not spread from the Thunder Bay region of Lake Huron.

### 4.3.4 Spiny Water Flea

The spiny water flea was first discovered in Lake Huron in 1984 and is believed to have entered the waters of the Great Lakes through discharged ballast water (Mills et al 1993). Although its average length is rarely more than 1.5 centimeters, this predacious zooplankter can have a profound effect on a lake's plankton community. The spiny water flea has colonized all offshore areas of the lake.

### 4.3.5 Zebra and Quagga Mussels

Zebra mussels reproduce rapidly and are able to form dense layered colonies of over one million per square meter. Zebra mussels are a serious threat to Lake Huron ecosystem because they have tremendous filtering capacity for sediments and phytoplankton (Fanslow et al 1995). In many regions of the Great Lakes zebra mussels have had severe impacts on many native unionids and are of special concern to threatened and endangered species of bi-valves. Also, zebra mussels are a serious concern because they contribute to the cycling of contaminants by removing PCBs from the sediments and reintroducing them into the food web (Jude 1996). Quagga mussels are similar to zebra mussels in many respects but do prefer deeper water. They therefore have the potential to detrimentally impact aquatic species that use the deeper portions of the lake.

### 4.3.6 Other Aquatic Nuisance Species

Eurasian watermilfoil (*Myriophyllum spicatum*) is one of the most common species found in Saginaw Bay. Populations have thrived since the introduction of zebra mussels that have contributed to higher water clarity. Decreased light levels allow for fewer species to survive. Eurasian watermilfoil also reroutes nutrients from plankton to uprooted plants, depriving energy to the fish community. Purple loosestrife (*Lythrum salicaria*) is a perennial wetland plant that is impacting Lake Huron wetland ecosystems by changing the structure, function and productivity of the wetlands. The plant forms dense monoculture stands sometimes hundreds of acres in size. Purple loosestrife can displace native vegetation and threaten the biotic integrity of wetland ecosystems. *Cercopagis pengoi*, the fishhook water flea, is one of the most recent invasive species to Lake Huron. Cercopagis are a problem because they tangle lines in both recreational and commercial fisheries and have a large appetite for zooplankton (Ontario Federation of Hunters and Anglers 1999). Further ecological disruptions have not been completely determined and, therefore, Cercopagis are being closely watched.



In the future, additional non-native species will likely be introduced into the Great Lakes food web and will have unknown effects making it even more difficult, if not impossible, to define reasonable expectations for an ever changing ecosystem.

### 4.4 References

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